Appendix C

Comparison of National Petroleum Council and Energy Information Administration Natural Gas Studies

Introduction

The National Petroleum Council (NPC) recently published a significant study that examines the outlook for domestic natural gas. This appendix compares the methods and findings of that study with the analysis of accelerated depletion presented in the study by the Energy Information Administration (EIA).

The NPC study, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand*, was prepared as an advisory report for the Secretary of Energy and was published in December 1999. The NPC study determined that "natural gas is poised to continue to make an important contribution to the nation's energy supply and its environmental goals through 2015 and beyond." The report provides a significant update to the previous (1992) NPC study on natural gas.

Discussion

Difference in Projections

Although the NPC and EIA studies use different analytical methodologies and resource databases, their findings are comparable, with some important differences.

- **The NPC study anticipates stronger near-term consumption of natural gas than does the EIA study.**

Projected gas consumption in 2015 in the NPC study is 2.5 trillion cubic feet higher than in EIA's Accelerated Depletion Case and 1.6 trillion cubic feet higher than in EIA's Reference Case (Table C1).

One reason for the higher projections of natural gas consumption in the NPC Study is that the NPC assumes a gross domestic product (GDP) growth rate of 2.5 percent per year, as compared with 2.2 percent in the EIA study. In support of the higher GDP growth rate, the NPC assumes a world oil price of about $16.50 per barrel for crude oil (in 1998 dollars), remaining flat from 2000 to 2015. The NPC world oil price is estimated from the price of West Texas Intermediate crude oil used in the NPC study, which is projected to remain constant at $18.50 per barrel. The EIA study assumes world oil prices of $20 to $21 per barrel (also in 1998 dollars) during the same period.

A major area of growth in U.S. gas consumption in the NPC study is gas-fired electricity generation. With dual-fuel combined-cycle and gas-fired combustion turbine capacity projected to grow from 25 gigawatts in 1998 to 140 gigawatts in 2015 in the NPC study, annual natural gas consumption in the electricity generation sector is projected to grow from 3.3 trillion cubic feet in 1998 to 7.8 trillion cubic feet in 2015. The NPC study points out that, should sufficient natural gas not be available to meet the fuel needs of new power plants, an additional 3.5 million barrels per day of distillate demand would be placed on the world market. The EIA study expects similar strong growth of gas demand in the electricity and independent power generation sectors.

The two areas that account for NPC's higher projections of natural gas consumption in 2015 are:

Table C1. Projected U.S. Consumption of Natural Gas, 1998-2020
(Trillion Cubic Feet per Year)

Year	NPC Study	EIA Study	
		Accelerated Depletion Case	Reference Case
1998	22.0	21.4	21.4
2005	26.3	23.4	23.6
2010	29.0	26.7	27.0
2015	31.3	28.8	29.7
2020	—	28.6	31.4

Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

- 1.3 trillion cubic feet higher projected use of natural gas in the industrial sector, particularly in the chemicals, refinery, and primary metals industries—attributable in part to higher GDP growth
- 1.3 trillion cubic feet higher projected use of natural gas in the residential and commercial sectors—attributable to larger homes, increased air conditioning, and growth in the service sector

- **The NPC study anticipates higher levels of domestic natural gas production.**

NPC's projection of domestic natural gas production in 2015 is 2.7 trillion cubic feet higher than projected in EIA's Accelerated Depletion Case and 1.4 trillion cubic feet higher than in EIA's Reference Case (Table C2).

The primary reasons for the higher projections of domestic natural gas production in the NPC study are:

- The NPC study projects higher wellhead natural gas prices, ranging from $3 to nearly $4 per thousand cubic feet during the study period. In contrast, wellhead natural gas prices range from $2.50 to $3 per thousand cubic feet in the Reference Case of this study. The lower prices in the Reference Case reflect to a considerable degree the lower EIA consumption levels, because supply and demand are balanced in EIA's National Energy Modeling System (NEMS) to obtain a market price. Accordingly, a substantial amount of the "price-related" higher production is attributable to higher demand in the NPC study.
- The NPC study uses a somewhat larger remaining lower 48 natural gas resource base of 1,446 trillion cubic feet, as compared with the estimates of 1,280 to 1,362 trillion cubic feet used in the EIA study.

The NPC projections of natural gas production are higher in two major areas: unconventional and offshore gas. The NPC study projects 8.5 trillion cubic feet of annual production from unconventional gas wells, as compared with 6.5 trillion cubic feet projected in EIA's Reference Case and 5.9 trillion cubic feet in the Accelerated Depletion Case. Similarly, the NPC study projects 7.6 trillion cubic feet of annual production from unconventional gas wells (the majority from the deep water of the Gulf of Mexico), as compared with 6.7 trillion cubic feet in the Reference Case and 6.0 trillion cubic feet in the Accelerated Depletion Case of this study.

- **The NPC study projects considerably higher near- and mid-term natural gas prices.**

The NPC study projects a price path for natural gas (at the wellhead) for the next 15 years that is considerably higher than the natural gas prices projected in this study (Table C3).

Table C2. Projected U.S. Production of Natural Gas, 1998-2020
(Trillion Cubic Feet per Year)

Year	NPC Study	EIA Study	
		Accelerated Depletion Case	Reference Case
1998	19.0	18.9	18.9
2005	22.6	19.1	19.4
2010	25.1	22.3	22.7
2015	26.6	23.9	25.2
2020	—	23.0	26.5

Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

Table C3. Projected Wellhead Natural Gas Prices, 2000-2020
(1998 Dollars per Thousand Cubic Feet)

Year	NPC Study[a]	EIA Study[b]	
		Accelerated Depletion Case	Reference Case
2000	3.14	2.48	2.48
2005	2.79	2.48	2.40
2010	3.14	2.62	2.48
2015	3.70	3.13	2.68
2020	—	4.12	2.79

[a]Henry Hub spot price.
[b]Average lower 48 wellhead price.
Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

The higher near- and mid-term natural gas wellhead prices act to stimulate an early surge in well drilling and annual gas well completions in the NPC study.

Differences in Inputs, Assumptions, and Methodology

- **The NPC study uses a somewhat larger natural gas resource base.**

In the NPC study, the size of the underlying natural gas resource base was shown to have the largest single impact on future natural gas prices and gas consumption. Consequently, considerable attention is given here to this important comparison. The NPC study assumes a lower 48 natural gas resource base of 1,446 trillion cubic feet, about 100 to 200 trillion cubic feet larger than the 1,280 to 1,362 trillion cubic feet assumed in the EIA study (Table C4). For comparison purposes, the EIA resource categories have been reallocated in Table C4 to match the resource groupings used in the NPC study.

Conventional Natural Gas

The NPC study assumes an undeveloped conventional natural gas resource base of 855 trillion cubic feet, as compared with 703 trillion cubic feet in the EIA study (Table C5).

After adjusting the EIA offshore new field discoveries for associated gas and reducing NPC reserve growth values for unconventional (tight) gas in old plays, these two areas are comparable; however, other differences remain:

- The NPC study expects 376 trillion cubic feet of additional new field discoveries from the lower 48 onshore, particularly from deep gas formations. After allocating associated gas (for comparability with NPC categories), the EIA study expects only 200 trillion cubic feet of comparable new field discoveries.
- The NPC study includes 76 trillion cubic feet of lower 48 offshore resources from areas in the eastern Gulf of Mexico, the Atlantic Outer Continental Shelf, and the Pacific Outer Continental Shelf that are currently restricted from development. NEMS does not include resources or areas that are restricted from development.

Table C4. Assumed Lower 48 Natural Gas Resource Base as of January 1, 1998
(Trillion Cubic Feet)

Resource	NPC Study	EIA Study[a]	
		Accelerated Depletion Case	Reference Case
Proved Reserves[b]	157	157	157
New Field Discoveries	633	450	450
Reserve Growth	[c]222	253	253
Unconventional Gas	454	420	502
New Plays	371	—	—
Old Plays	[c]83	—	—
Total	**1,446**	**1,280**	**1,362**

aAfter allocating 124 trillion cubic feet of associated gas to new fields (94 trillion cubic feet) and reserve growth (30 trillion cubic feet). The estimated proved reserves of associated gas do not influence production in the NEMS Oil and Gas Supply Module but are included in the Resource Table to provide a total gas resource accounting that is consistent with other EIA reports.
[b]Total U.S. proved reserves are estimated at 167 trillion cubic feet in both studies.
[c]After allocating 83 trillion cubic feet of reserve growth in old tight gas plays to unconventional gas.
Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

Table C5. Assumed Lower 48 Conventional Gas Resource Base as of January 1, 1998
(Trillion Cubic Feet)

Resource	NPC Study	EIA Study
New Field Discoveries	633	450
Onshore	376	200
Offshore	257	250
Shallow	118	70
Deep	139	180
Reserve Growth	222	253
Total	**855**	**703**

Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

There are also considerable differences between the NPC and EIA estimates of the natural gas resource base for Alaska; however, Alaska's natural gas resources have no impact on the results through 2015, and they are not discussed here. A comparison of the total lower 48 natural gas resource assumptions used in the two studies is shown in Table C6.

Unconventional Natural Gas

In both the NPC and EIA studies, a significant portion of the increase in domestic natural gas production is expected from unconventional resources—tight gas, coalbed methane, and gas shales. The underlying in-place resource for these three gas supply sources is massive, approaching 10,000 trillion cubic feet; however, only a small portion of the resource (less than 10 percent) is judged to be of sufficient quality to be accessible with current exploration and production technology.

For the EIA study, the resource base, reserves, and production data for unconventional natural gas used in NEMS were updated. The updates captured geologic and development information on significant new gas plays—specifically, Powder River Basin coalbed methane, Wind River Basin tight gas, and Fort Worth Basin gas shales—increasing the total estimate of technically recoverable unconventional gas as of 1998 to 403 trillion cubic feet (Table C7).

After adjusting the NPC unconventional gas resource base for resource growth in old tight gas fields (as discussed in the 1992 NPC natural gas study), the NPC

Table C6. Assumed Lower 48 Total Natural Gas Resource Base as of January 1, 1998
(Trillion Cubic Feet)

Resource	NPC Study	EIA Study	
		As Reported	With Associated Gas Allocated
Proved Reserves	157	157	157
Conventional			
New Field Discoveries	633	356	450
Onshore	376	172	200
Offshore	257	184	250
Shallow	118	63	70
Deep	139	121	180
Reserve Growth	222	223	253
Unconventional	**454**	**502**	**502**
Tight Gas	230	351	351
Coalbed Methane	74	86	86
Gas Shales	52	65	65
Other	15	—	—
Reserve Growth	[a]83	—	—
Associated Gas	—	124	[b]—
Total	**1,446**	**1,362**	**1,362**

[a]Using unconventional gas resource growth of 83 trillion cubic feet to match aggregate values in summary tables.
[b]After allocating 94 trillion cubic feet to new fields and 30 trillion cubic feet to reserve growth.
Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

Table C7. Assumed Lower 48 Unconventional Gas Resource Base as of January 1, 1998
(Trillion Cubic Feet)

Resource	NPC Study (Current Technology Resource Base)	EIA *AEO2000* Resource Base	EIA Study Updated Resource Base
Tight Gas	178	271	286
Coalbed Methane	59	55	62
Gas Shales	39	52	55
Subtotal	286	378	403
Growth of Tight Gas/Other Fields	98	[a]—	[a]—
Total	**384**	**378**	**403**

[a]Included in EIA resource values for tight gas, coalbed methane, and gas shales.
Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

Reference Case Current Technology Resource Base and this study's numbers for unconventional gas resources at the beginning of January 1998 are comparable.

The technically recoverable unconventional gas resource base increases with time and technology progress. The NPC study recognizes this by looking forward and establishing an unconventional gas resource base of 454 trillion cubic feet in 2015. The NPC calls this its Reference Case Advanced (Year 2015) Technology Resource Base, which is used throughout its 1999 report. The current EIA study uses a similar resource growth and technology progress methodology for unconventional gas resources. The projected resource base for unconventional gas in the Accelerated Depletion Case is 420 trillion cubic feet in 2015—less than the 502 trillion cubic feet used in the Reference Case in 2015 because of the smaller fields and slower technology progress established for the Accelerated Depletion Case. The projected resource base comparisons for 2015 are shown in Table C8.

- **The treatment of access to resources is fundamentally different in the NPC and EIA studies.**

For the lower 48 onshore, the NPC first looked at the environmental restrictions that either preclude or delay access to Rocky Mountain natural gas resources, concluding that 137 trillion cubic feet of natural gas in the area is affected by access issues—29 trillion cubic feet in areas closed to development and 108 trillion cubic feet in areas where access issues would add significant costs and an average 2-year delay to well drilling. In addition, the NPC identified 76 trillion cubic feet of natural gas resources in offshore areas that are currently inaccessible—21 trillion cubic feet in the Pacific, 31 trillion cubic feet in the Atlantic, and 24 trillion cubic feet in the Eastern Gulf of Mexico.

The EIA study uses a much broader definition of lack of access that includes restrictions and delays due to environmental regulations, lack of adequate pipeline outlet capacity, and other barriers to development. The restrictions in the EIA model are lifted over time. Although an exact comparison of the access restrictions assumed in the NPC and EIA studies is not possible, the EIA study finds that currently 108 trillion cubic feet of the Rocky Mountain natural gas resource is affected by environmental and other restrictions. With no lifting of access restrictions, the EIA study estimates that 97 trillion cubic feet of the Rocky Mountain gas resource will be inaccessible even by the year 2020. Providing "high access" to Rocky Mountain natural gas resources reduces the estimate of inaccessible Rocky Mountain resources to 18 trillion cubic feet by 2020. Currently restricted drilling areas, such as the Eastern Gulf of Mexico and the Alaskan National Wildlife Refuge, are not included in the EIA model.

- **The NPC and EIA studies assume different rates of improvement in exploration and production technology.**

The rate of technology progress (advance) was shown in the NPC study to have the second largest impact (after the size of the resource base) on projections of future natural gas consumption and prices. The NPC study used annual rates of technology progress for cost reductions and drilling success rates that are considerably higher than those used in the EIA study (Table C9); however, the rate of technical progress for reserve additions per conventional well in the EIA study is considerably higher than that in the NPC study.

Although the annual differences in the rates of technology progress are modest, their cumulative effects over the 17-year period from 1998 to 2015 are considerable. For example:

- The NPC study assumes a 2.5-percent annual reduction in drilling costs for unconventional gas wells, compared with 0.5 percent in the EIA study. The result is a 40-percent reduction in costs by 2015 in the NPC study, compared with 10 percent in the EIA study.
- The NPC study assumes a 2.1-percent annual increase in reserve additions per low-permeability

Table C8. Assumed Lower 48 Unconventional Gas Resource Base as of January 1, 2015
(Trillion Cubic Feet)

Resource	NPC Study	EIA Study	
		Accelerated Depletion Case	Reference Case
Tight Gas	230	304	351
Coalbed Methane	74	68	86
Gas Shales	52	58	65
Subtotal	356	420	502
Growth of Tight Gas/Other Fields	98	[a]—	[a]—
Total	**454**	**420**	**502**

[a]Included in EIA resource values for tight gas, coalbed methane, and gas shales.

Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.

gas well, compared with 1.5 percent in the EIA study. The result is a 35-percent increase in reserve additions per well by 2015 in the NPC study, compared with 25 percent in the EIA study.

- The NPC study assumes a 1-percent annual increase in reserve additions per conventional offshore well, compared with 4 percent in the EIA study. The result is a 16-percent increase in reserve additions per well by 2015 in the NPC study, compared with 80 percent in the EIA study.

Summary

Overall, the NPC study projects a higher level of natural gas production than is projected in the EIA study, either in the Reference Case or in the Accelerated Depletion Case. The NPC study starts with higher natural gas consumption met by higher domestic natural gas production, supported by higher natural gas prices at the wellhead, a larger domestic natural gas resource base, fewer restrictions on access to Rocky Mountain resources, and different rates of technology progress.

Table C9. Assumed Rates of Technology Progress for Costs, Drilling Success Rates, and Reserve Additions per Well for Lower 48 Natural Gas, 1998-2015
(Percent Improvement per Year)

Area of Improvement	NPC Study	EIA Study	
		Accelerated Depletion Case	Reference Case
Drilling and Completion Costs			
Onshore Wells	2.5	1.29	1.29
Shallow Offshore Wells	2.5	2.02	2.02
Deep Offshore Wells	3.0	2.02	2.02
Unconventional Gas Wells	2.5	0.50	0.50
New Field Exploration Success			
Conventional	1.5 to 2.2	0.50	0.50
Unconventional[a]	—	0.00	0.25
Reserve Additions per Well			
Conventional Onshore			
Shallow	1.0	0.27	0.27
Deep	1.0	1.61	1.61
Conventional Offshore	1.0	4.14	4.14
Low Permeability	2.1	0.25	0.25
Unconventional	1.5 to 3.0	0.25	0.75 to 1.75

[a]Combined exploration and development success for unconventional gas in the EIA study.

Sources: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (Washington, DC, December 1999); and Energy Information Administration, Office of Integrated Analysis and Forecasting, National Energy Modeling System runs OGBASE.D051200A and OGDEPL.D051200A.